IWOCL 2024

The 12th International Workshop on OpenCL and SYCL

RusticL:
Compute for the Linux desktop?

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Who am I?

- Mesa contributor since 2016
- Works on Nouveau and OpenCL
- Part of Red Hat's GPU team since 2018
- Added support for system SVM to mesa's old CL driver
- Started rusticl in 2021
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- Participates in the OpenCL WG
- ~~Turns into a spec lawyer~~

The situation

The Linux desktop

- Compute hasn't seen much adaption
- Lack of good runtimes/APIs?
- A lot of packaging work?
- What alternatives exist?

Applications

- CLBlast
- Darktable
- Davinci Resolve
- GIMP
- Libreoffice Calc
- OpenCV
- Couple of smaller ones

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- There aren't that many actually

What lead do this?

- Bad reputation of clover, AMD only
- Fragmented Eco system
- People think OpenCL is dead
- No out-of-the-box availability

Alternatives

Requirements

- It needs to run everywhere
- People still use GPUs from 15 years ago on modern desktops!
  - Got a recent report of Firefox crashing on GeForce 6000 GPUs :')
- Users just want to use it
- App developers don't want to become compute experts
- Want to use their favorite programming language

OpenGL

- Doesn't see new features or concepts
- However it's easier to use than Vulkan
- Limited compute capabilities
- GLSL
- SPIR-V support probably broken

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- Rusticl can run on top of Vulkan

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- Actively developed

SyCL

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- Actively developed
- It's not a runtime API

$\Rightarrow$ Runtime lock-in at compile time

- AdaptiveCPP might make SyCL more interesting?

X

- Alternatives generally vendor or language locked-in
- Desktop features don't want to rely on it to function
  - What if an accessibility feature relies on e.g. CUDA?
  - What if you have to be a C++ developer to use it?

OpenCL

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- Everything is abstracted
- Experiences a revival
- SPIR-V support
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- No

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- Unless your distribution packages OpenCL runtimes
- Rusticl could fix this!

The solution?

Rusticl

- Rust based OpenCL 3.0 implementation in Mesa using Gallium
- Multi-threaded
- Mesa: FOSS cross-vendor GPU driver
- Gallium: driver abstraction

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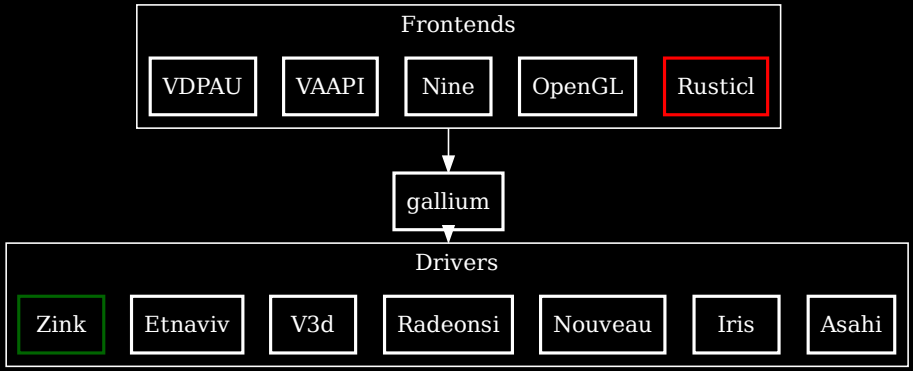
- Mesa: FOSS cross-vendor GPU driver
- Gallium: driver abstraction
- ... and my first Rust project

Why Rust?

Why Rust?

- I wanted to learn about rust
  - Is it feasible inside mesa?
  - Is it feasible for an OpenCL impl?
- Removes entire classes of bugs
- Easy to write thread-safe code
  - *Arc*, *Mutex* and closures help a lot!

Gallium


Frontends
VDPAU
VAAPI
Nine
OpenGL
Rusticl
gallium
Drivers
Zink
Etnaviv
V3d
Radeonsi
Nouveau
Iris
Asahi

Rusticl compiler stack

- Uses the LLVM-SPIRV-Translator for OpenCL C
- Optimized for SPIR-V input
  - causes issues, because everybody else uses LLVM
- NIR as mesa internal IR
  - optimization and lowering passes
- gets translated to Vk SPIR-V for Zink

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- Unless you opt-in

The Journey so far

Making Mesa compute ready

- Mesa's compiler is not LLVM based
  - Adding a structurizer (also used for NVK)
  - Supporting pointers
  - Supporting function calls (ongoing)
- Advanced compute features
  - SVM (also ongoing)

Use inside Mesa

- Shader lowering
  - Ray tracing
  - GS/TCS/TES for GPUs not supporting it
  - Internal shaders for Intel
- Shared code between host and GPU
- Memcpy

What about supporting other APIs?

- Implementing optional features for:
  - SyCL: DPCPP or AdaptiveCPP
  - CUDA/HIP: chipStar
- Level Zero: no concrete plans

So where are we going with this?

Things OpenCL might want to improve

- Performance pitfalls
  - *HOST_PTR*
  - API validation can be expensive
  - Almost no feedback on optimal usage
  - Multi device support feels too implicit
- SVM/USM/BDA
- Add explicit client VM management? Or sparse?

Ecosystem

- Early SPIR-V validation in
  - SPIRV-LLVM-Translator
  - DPCPP
  - LLVM SPIR-V backend
- Easier packaging
- Better debugging tools
  - need more tools like the opencl-intercept-layer

Where I want to see more Compute

- Video encoding/decoding?
  - AV1 is cool and all, but what about old hardware?
- Accessibility?
  - Disclaimer: I'm not an accessibility expert

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  - Summaries of long texts
- More High level APIs
  - Apple does this and are very successful with this?

SPIR-V

- More focus on SPIR-V
- OpenCL C should not be the only way to write kernels!
- Make others use it (e.g. HIP or openpm)
- SPIR-V should become the de-facto compute IR

Other Considerations

- Laptops often have slow GPUs
  - requiring beefy GPUs for AI/ML is not great
- Unified memory often slow! (Apple solved this)

Questions?